The development of the perfective past-tense in Greek child language acquisition and the single-dual mechanism debate[1]

Maria Kotroni
Aristotle University of Thessaloniki
mkotroni@hotmail.com

Abstract: This paper addresses the question of the representation of morphologically complex verb-forms in a micro-developmental study of sigmatic and non-sigmatic past-tense forms. With this respect, three models of morphological processing are tested, namely single-mechanism, dual-mechanism and rule-based models. The main observation is the dissociation between regular and irregular processes regarding both generalisation properties and developmental patterns. Additionally, regular inflectional forms were found to overapply to verbs that require irregular forms, but not vice versa. Overregularisation is found to be a rare phenomenon in child language and adult-frequency of an irregular verb in its past-tense form appeared to be negatively correlated with its overregularisation rate for children. This investigation in a morphologically rich language adds further empirical evidence to the controversy between single and dual-mechanism models. The findings mainly support the latter, which differentiate between rule-based and memory-based representations.
Key words: language acquisition, morphological processing**,** overregularisation, irregularisation, single vs dual mechanism, dissociation.

1. Accounts and their prediction on the mental representations of past-tense forms

1.1 Rule-based account

Its supporters[2] postulated a rule-based system for morphological processes. All inflected words are considered to be produced through morphologically conditioned phonological rules. Thus, past tense forms are generated by a single rule-based process, derived by rules from the abstract mental representations by means of an affixation rule in the case of regulars, and a morpho-phonological rule in the case of irregulars. Memorisation of inflected words is avoided, thus no frequency and similarity effects are expected. As a result, no qualitative difference is predicted between regular and irregular past-tense formation processes.

1.2 Associative single-mechanism account[3]

It belongs to the connectionist framework. Implementation of a single procedure is introduced. All inflected words (both regular and irregular) are stored and processed within a single-associative system. They deny any kind of abstract representations (rules and symbols) in the mental grammar and assume simple associations in a behaviouristic, stimulus-response style. The internally represented combinatorial operations are

[1] This paper draws upon a larger empirical study I conducted at the University of Essex supervised by Prof. Harald Clahsen. The study has been supported by a postgraduate scholarship from the Greek State Scholarship Foundation (IKY).
[2] Chomsky 1965, Chomsky and Halle 1968, Halle and Mohannon 1985, Ling and Marinov 1995, Yang 2000 among others
[3] Rumelhart and McCleland 1986, McWhinney and Leinbach 1991, Daugherty and Hare 1994, Plunkett and Marchman 1993, Plunkett and Juola 1999, Elman et al 1996, Joanisse and Seidenberg 2005 among others

substituted by associative networks operating without any combinatorial principles. Such networks consist of nodes and connections between the nodes. Generalisations in children's use of inflected word forms follow from the formation of patterns between existing word forms.

With regard to the past tense, the child learns to associate two corresponding forms, the present and the past tense form. In order for the child to produce the past-tense of an unknown verb, he/she recognizes the similarity between the known and the unknown verb form and forms the corresponding past form by analogy. Exposure weakens wrongly set up associations. Thus the strength of an association is adjustable. Frequency plays an important role for the development and adjustment of associations. Overregularisation is not rule-based but the overregularised form yields a strong pattern with a high level of resting activation, due to an overwhelming increase of the proportion of regulars in the child's input. Thus it is more accessible. Patterns that have a high frequency (regular forms) will generalise more productively than patterns with a low type-frequency (irregular forms). Such models showed incapable of generalising to novel items to the extents that humans do.

1.3 Dual-mechanism models

The present study focuses on the Words-and-Rules Model[4]. It combines aspects from the symbolic and connectionist models. The language faculty is hypothesized to have a modular structure, with two representational systems of morphologically complex forms (Marcus et al 1992, Marshall and Van der Lely 2005, Clahsen 1999, Clahsen et al 2004, Thomas et al 2001): *an associative memory*, a mental lexicon of structured entries listed in the memory which extracts probabilistic contingencies such as frequency and similarity, and a *computational system* of rules which generalise over symbolic categories. Thus, adults have access to two processing routes activated in parallel, one accessing irregularly inflected entries from the mental lexicon and another involving morphological decomposition of regularly inflected words into stem and affix representations. However, the existence of an irregular form in the lexicon and its retrieval will block application of the regular formation rules.

Distinct generalisation properties are expected to be found between regular and irregular morphological patterns: (a) irregularly inflected forms are highly sensitive to both word frequency and similarity; (b) irregular forms cannot be predicted by the base-forms but they are memorised forms stored in the mental lexicon. Regular forms are predictable in form; (c) regular patterns generalise to novel forms regardless of frequency and similarity. Irregular patterns generalise to novel forms only as a function of similarity with existing irregular patterns; (d) only regular affixes can be overregularized; (e) correct irregular inflections (stored in memory) should occur before productive regular inflections (requiring a morphological rule); (f) the scope of rules (only restricted by general principles) is wider than analogy so regular generalisations have a higher productivity value.

The present study conducted on a synthetic language with particularly rich verb morphology offers a better insight in the underlying representation of regular and irregular forms. Greek past-tense forms do not confront us with confounding variables such as presence or absence of an affix and the huge frequency differences met in English.

[4] Pinker and Prince 1992, Pinker 1991, 1999, Clahsen 1999, Pinker and Ullman 2002

2. Verb inflection in Greek

2.1 Past tense formation (perfective past tense)

The active past perfective form is divided into two categories: sigmatic, including the aspectual marker –s, and non-sigmatic without the aspectual marker. We adopt Holton et al (1997)'s analysis of past tense formation in Greek, who provide a rule-based paradigm for the formation of regular perfective past forms, including 1st and 2nd conjugation verbs. Those verbs which do not form their perfective stems conforming to this paradigm are irregular (unpredictable).

2.2 Stem formation and suffixation

The account for the internal verb structure adopted by Joseph 1992, Philippaki-Warburton 1990, Tsapkini et al 2002a-b, who provide a morphosyntactic analysis of the verbs in features is followed.

Table 1. Analysis of the verb in its features

(augment)	root	voice	aspect	tense	concord	translation
-	pli-	-th-	-ik-	-a-	-me	we were washed
-	idri-	Ø	-s-	-a-	-me	we established
(e-)	-do-	Ø	-s-	Ø	-es	you gave

We distinguish between errors of inflectional suffixation and stem-errors, because both a root and an aspectual marker change were detected. No variation in tense, voice and concord were detected.

3. Method

The existing PPT Task (Clahsen and Stavrakaki 2004) was used.

3.1 Participants:

The performance of 13 Greek monolingual normally developing children was investigated. The language samples were recorded over a period of four weeks in five sessions and 2850 responses were collected for production

Table 2. Group's profile: chronological age

Group	Age Range	Mean
1	3;6;23-3;11;27	3;9;27
2	4;8;7-4;10;9	4;9;26
3	5;2;7-5;4;25	5;3;10

3.2 Materials

There were 50 verbs in the indicative mood divided into three conditions

a. 20 existing verbs comprising: 10 verbs with regular sigmatic past perfective e.g. *grafo-egrapsa, lino-elisa* and *milao-milisa* and 10 with irregular non-sigmatic past perfective e.g. *troo-efaga, pleno-eplina* and *zesteno-zestana*

b. 20 novel rhyming verbs differing from existing verbs in the onset: 10 verbs similar to sigmatic perfective past-tense forms e.g. *drafo, vino* and *kripao* and 10 verbs similar to non-sigmatic perfective past tense forms e.g. *proo, verno* and *kesteno*

c. 10 novel non-rhyming verbs, e.g. *stothi, goutheni, taprini, kirovi* etc

3.3 Procedure

The experimenter names the activities that the child does everyday and the child is asked to describe the completed activity after a past perfective prompt.

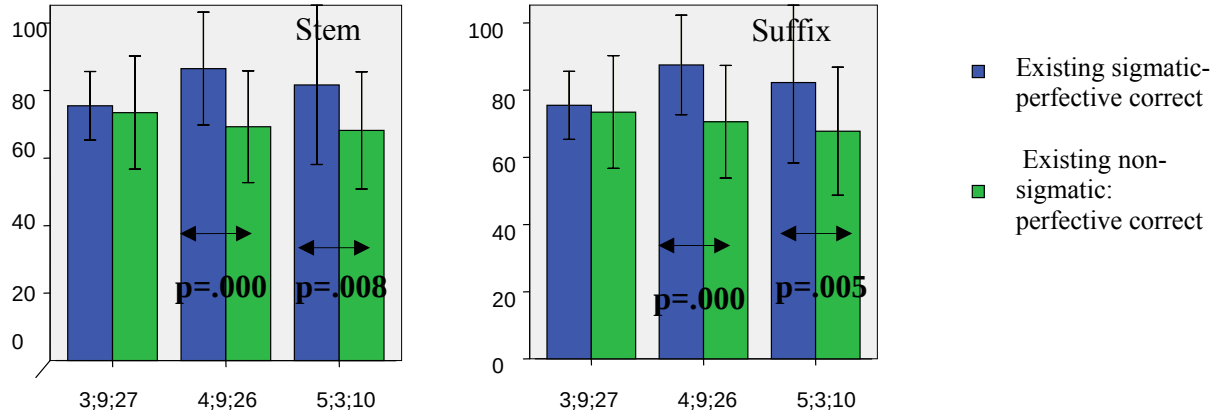
4. Results

4.1 Age-group analysis

4.1.1 Existing-verbs

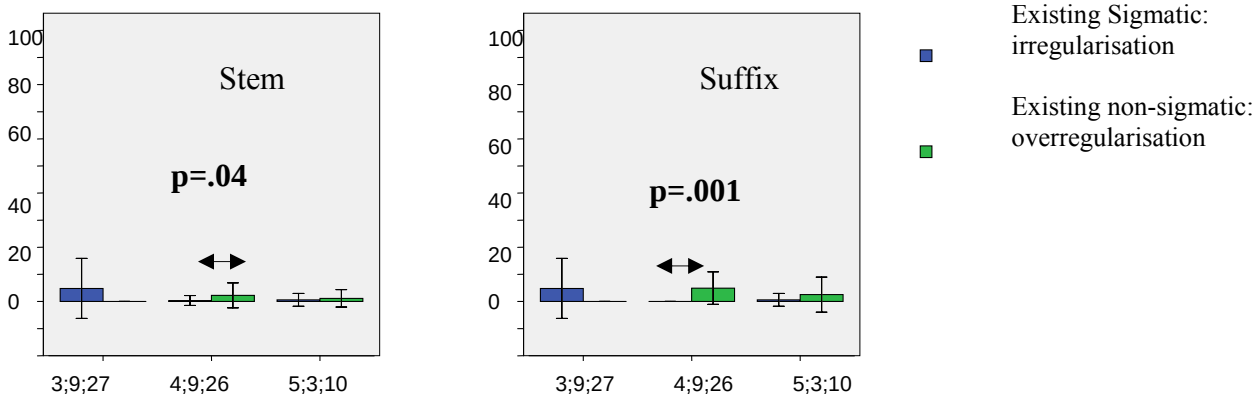
In Figure 1, correctness scores in the production of existing-sigmatic and non-sigmatic verbs are presented. There is a significantly better performance in the regular forms than the irregular ones in the second and third group. The youngest group may have not acquired an accurate morphological rule-system yet.

Figure 1. Existing sigmatic perfective correct vs Existing non-sigmatic perfective correct - stem and suffix analysis



If we compare overregularisations with irregularisations, group 1 should not be taken into account, since the onset of the former has not taken place. Within the second group, the overregularisations outnumber irregularisations significantly (stem: p=.040, suffix: p=.001). Within group 3, the pattern is in accordance with the second group, although the results are not significant. However, this may be explained on the face of the decline in the overregularisation rate, as the U-shaped pattern starts diminishing with age.

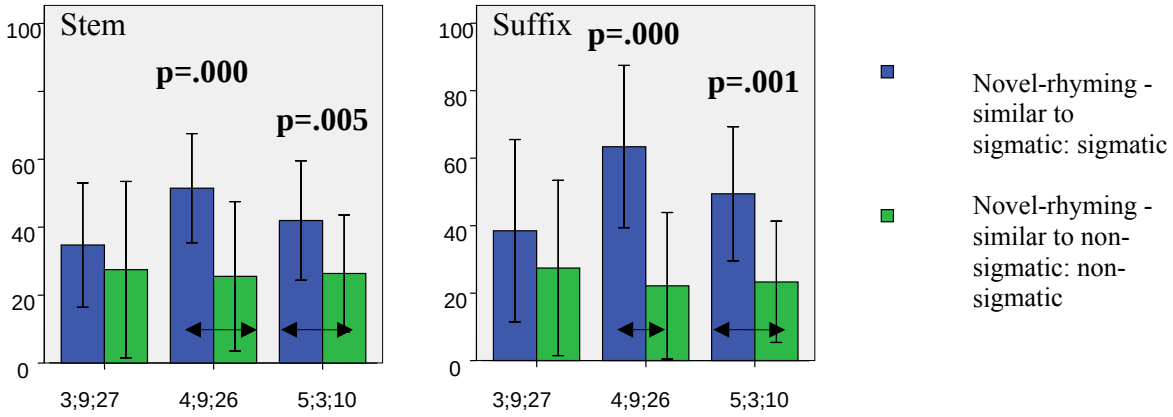
Figure 2. Existing verbs-overregularisations and irregularisations (stem and suffix)



4.1.2 Novel-rhyming verbs

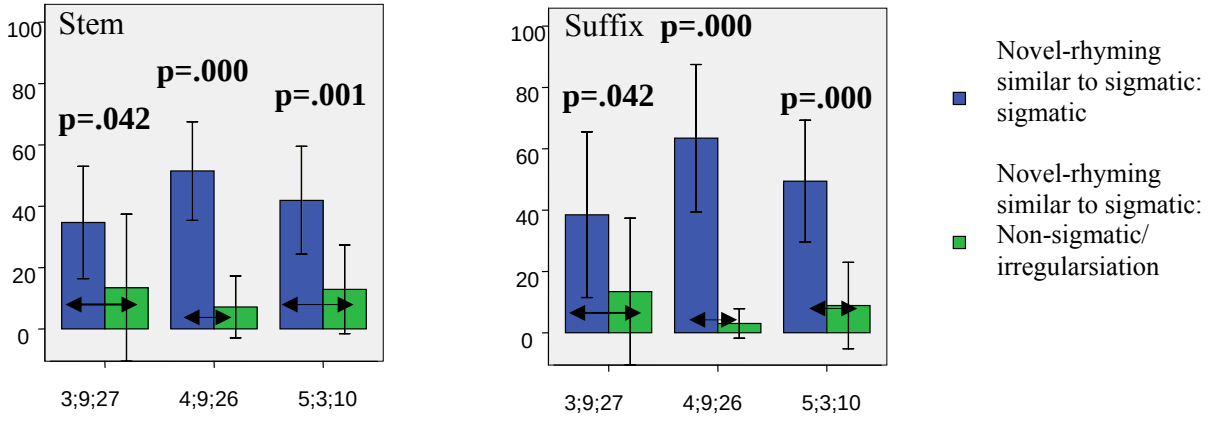
Regarding correctness scores, in both stem- and suffix-analysis, all three groups perform better in verb-forms that are analogous to regular forms than those verbs that are formed in analogy to irregular existing-verbs. Within groups 2 and 3, this distinction is significant in both analyses (group 2: stem p=.000, suffix p=.000, group 3: stem p=.005, suffix p=.001). The deviant performance of the first group can be explained as an indication of a partially acquired system of morphophonological rules and as the result of a deviant performance of one participant who shows the reverse pattern.

Figure 3. Novel-rhyming verbs and preference for sigmatic/non-sigmatic



Within the class of novel-rhyming verbs, similar to sigmatic (regular formation), the three groups showed statistically significant preference for regular stem-formation and suffixation compared to irregular one (group 1: stem/suffix p=.042, group 2: stem/suffix: p=.000, group 3: stem p=.001, suffix: p=.000).

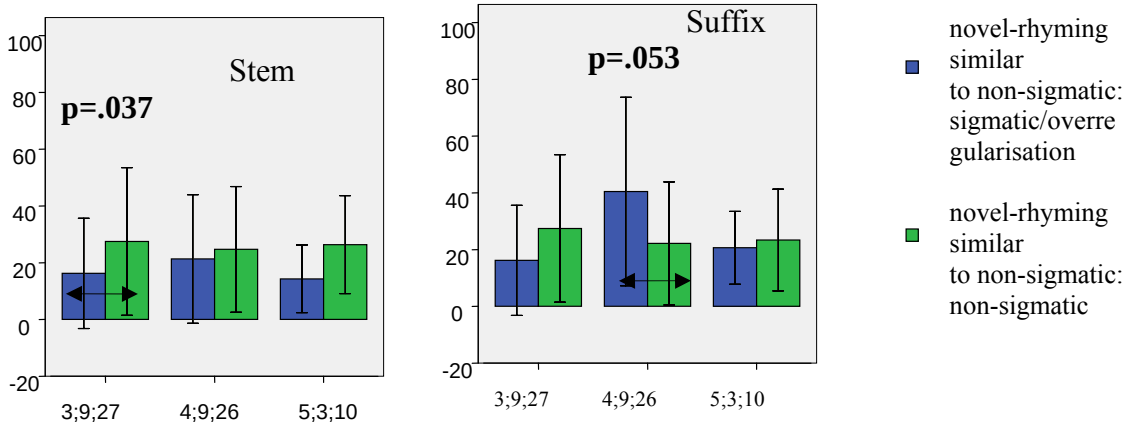
Figure 4. Novel-rhyming verbs, similar to sigmatic



Although analogy is involved in both pseudo-regular and pseudo-irregular, it seems stronger in the case of those novel-rhyming verbs that are similar to non-sigmatic existing-verbs as it becomes obvious in the Figure below. Thus, within the class of novel-rhyming verbs that are similar to non-sigmatic, there is a tendency to produce irregular forms than overregularize. In Group 1, stem alternations are significantly more than the overregularisations (p=.037). Within group 2, a non-significant or a marginally significant dissociation exists, still the irregular formation outperforming overregularisations. This may not show a low production of irregular forms, but it may

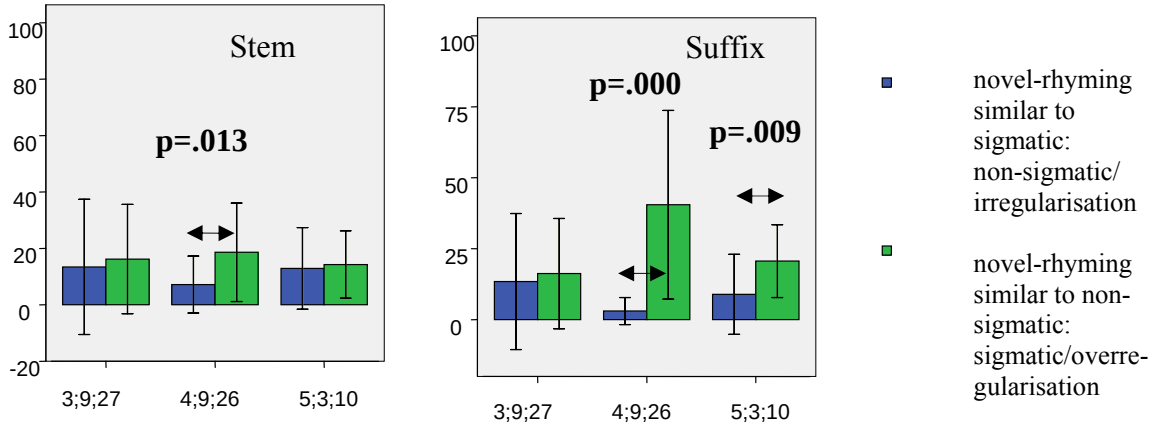
be an indication of a period of increased overregularisations, corresponding to a U-shaped developmental pattern. Within Group 3, although irregular formation is preferred over the overregularisation, such a difference is not significant.

Figure 5. Novel verbs rhyming to non-sigmatic



But, if we further compare pseudo-irregularisation with pseudo-overregularisation errors, it is clear that all three groups show higher preference for overregularisations, which indicates a dissociation between regular and irregular patterns. However this is not always statistically significant. Within Group 1, this pattern is not significant. Regarding group 2, the dissociation is significant in both analyses (p=.013 and p=.000) and within Group 3, the dissociation is significant only in the suffix analysis (p=.009).

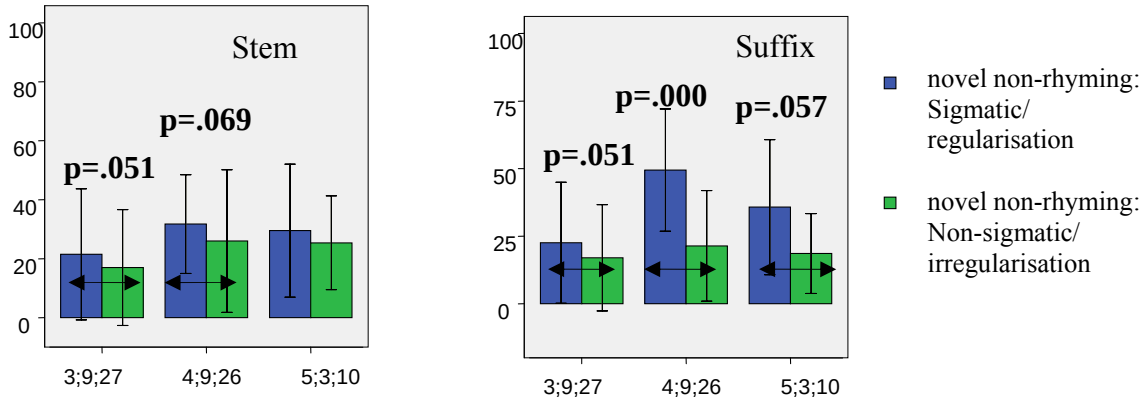
Figure 6. Novel rhyming verbs-overregularisation and irregularisation



4.1.3 Novel non-rhyming verbs

With regard to novel non-rhyming verbs, all three groups showed a preference for producing regular forms than irregular ones, concerning both stem and suffix-formation. Group 1 showed a significant dissociation (*p*=.051, one-tailed). Within Group 2, the dissociation was marginally significant in the stem-analysis (*p*=.069) and significant in the suffix-analysis (*p*=.000). Within group 3, irregularisations and regularisations do not differ significantly in the suffix-analysis (p=.057).

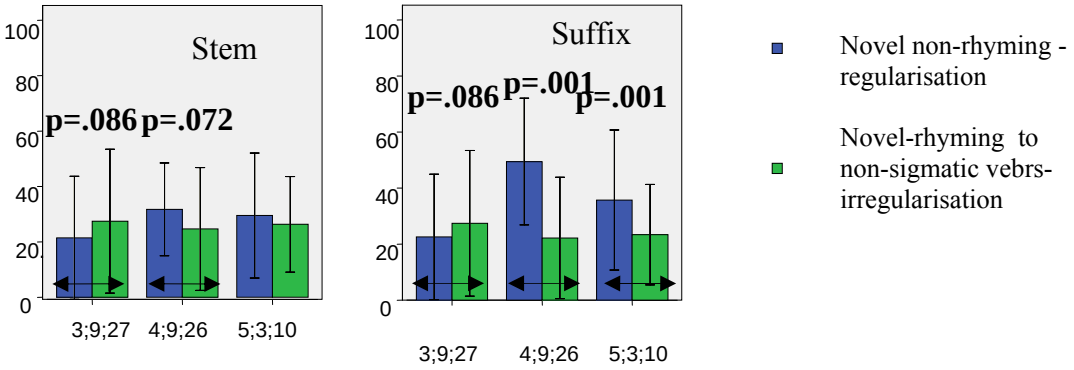
Figure 7. Novel non-rhyming verbs- regularisations vs irregularisations



4.1.4 Existing vs novel-verbs: the role of analogy

We also investigated the role of analogy in the performance of irregular verbs in contrast to regulars. In Figure 8, we compare novel non-rhyming verbs with preference for sigmatic (no analogy involved, rule-based pattern) with novel verbs rhyming with non-sigmatic that show preference for a non-sigmatic form (analogy involved). Regarding the first group, analogy seems to have a stronger effect than the application of a rule. However, such dissociation is only marginally significant. This may be the result of a rule not acquired completely yet. Within the second and the third group, the reverse pattern is observed. The application of a rule outperforms the role of analogy.

Figure 8. Regularisation vs irregularisation (novel verbs)



4.2 Developmental analysis

We adopt *a two-fold analysis*: an age-group and a developmental analysis, whose role is additive. In the former the different points in time, though dense, are considered to be a series of snapshots and are analysed quantitatively and in a cumulative fashion. In the latter, we examine the process of change in abilities during short time spans.

The aim of this section is to investigate whether regular and irregular patterns of development are dissociated in Greek child-language acquisition of production of past-tense forms. Converging results from all children are aggregated and combined in a developmental sequence, because of the limited sample available.

4.2.1 Existing-verbs

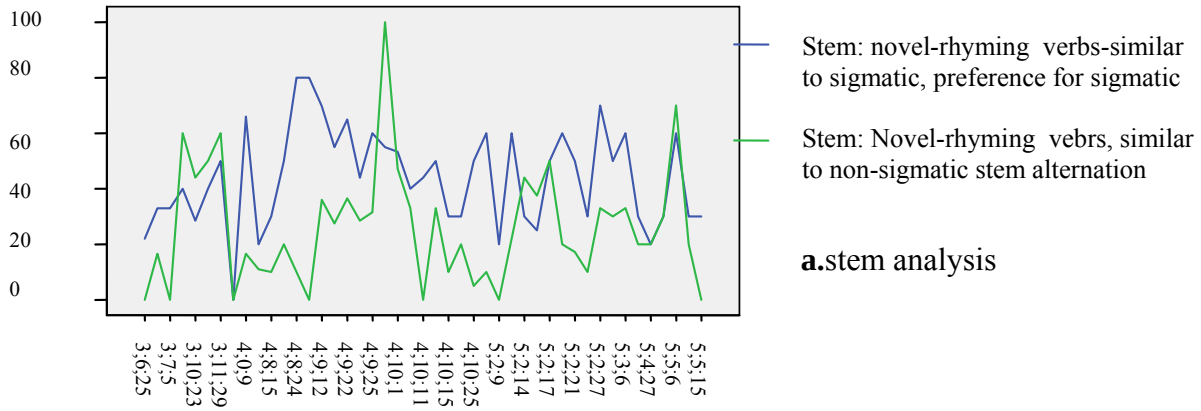
In the following Figures that show the parallel performance of existing regular and irregular verbs, the developmental patterns of regular and irregular verbs are dissociated both quantitatively and qualitatively in nature. We should bear in mind that no significant difference was found in frequency of regular and irregular verbs.

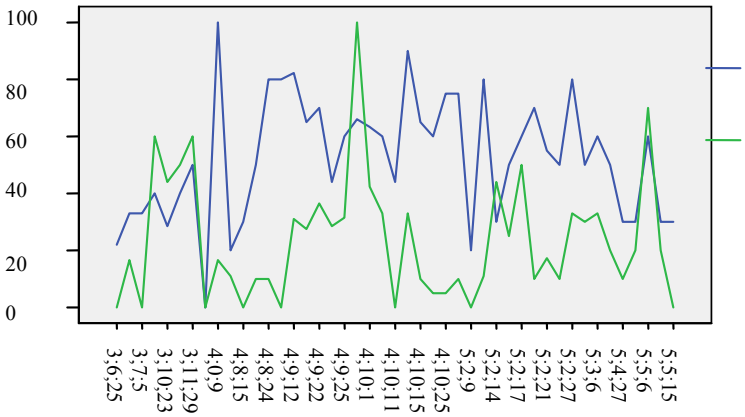
Figure 9a and b. Developmental analysis of Existing (regular and irregular verbs)

4.2.2 Novel-rhyming verbs

The previous observation is more apparent in the case of the novel-rhyming verbs. Once more, the dissociation augments in the middle-age group.

Figure 10a and b. Novel-rhyming verbs





b. suffix analysis

4.2.3 The role of frequency

4.2.3.1 Relation between overregularisation rate of verbs and their word frequency

Table 3. Word Frequency of irregular past-tense forms of existing-verbs (Clahsen and Stavrakaki, 2004)

High frequency words			Low Frequency words		
Past-tense form	‰	Overr errors	Past-tense form	‰	Overr errors
ide	83.8	0	efaje	8.7	0
efere	64.4	0	ipie	3.2	0
			ejire	2.7	9
			espire	1	3
			zestane	0.4	1
			epline	0.3	1
			ifane	0.1	3
			kontine	0.1	2
Mean		0	Mean	2.7	2.38

The analysis revealed that all the overregularisation errors occurred in the low-frequency forms, with a mean of 2.38 overregularisation errors per existing irregular past-tense form. Frequent exposure strengthens memory-representations of a high-frequency irregular form, which is more accurate than low-frequency ones. Therefore, the effect of frequency on overregularisation errors becomes even more obvious.

4.2.3.2 The role of frequency with regard to regular past-tense forms.

The table below reveals that frequency plays no role in the correctness scores of regular forms. Regularly inflected forms need not be stored and the similarity of a given stem to previously encountered ones plays no role. The high frequency words (mean frequency rate: 43.2‰) exhibited 10 errors in average, whereas the low-frequency words (mean frequency: 2.1‰) exhibited 7.2 errors in average, which is augmented as an artefact, by the error-rates of the verb '*eplase*': 20 errors.

Table 4. Word-Frequency of regular past-tense forms of existing-verbs

High frequency words			Low Frequency words		
Past-tense	‰	errors	Past-tense form	‰	errors
epese	59.6	8	halase	6.3	3
egrapse	58.1	13	elise	4.1	3
ekopse	12	9	kouvalise	1.2	3
			tripise	0.9	5
			evapse	0.8	8
			eplase	0.7	20
			edise	0.6	9
Mean	43.2	10	Mean	2.1	7.2

We also calculated the overregularisation rate for individual children and the overall overregularisation rate. Marcus et al (1992)'s rationale is adopted. The average overregularisation rate in the existing irregular verbs across the 13 children was 3.9%. Thus, overregularisation is a relatively rare phenomenon. However, the analysis of the novel-rhyming verbs showed that the overregularisation rate is higher: 47.8%. Still it is far from overregularising 100% of the times and smaller than 50%.

Table 5. Overregularisation rates for individual children

Child	Existing non-sigmatic				Novel-rhyming non-sigmatic			
	Corr irreg	Overreg tokens	Total	Overreg rate	Corr irregular	Overreg tokens	Total	Overreg rate
Giorgos T	36	2	38	0.052	9	9	18	0.5
Giorgos P	20	0	20	0	12	8	20	0.4
Panag	21	1	22	0.045	9	6	15	0.4
Kon-nos	36	3	39	0.077	3	14	17	0.82
Christos	40	0	40	0	10	12	22	0.54
Georgia	36	1	37	0.027	16	5	21	0.23
Lefteris	20	2	22	0.090	6	13	19	0.68
Iliana	36	4	40	0.1	0	48	48	1
Ioanna	39	1	40	0.025	14	21	35	0.6
Christ	37	4	41	0.097	19	7	26	0.27
Eva	25	0	25	0	15	7	22	0.32
Thanassis	14	0	14	0	1	0	1	0
Kon-nos K.	18	0	18	0	7	6	13	0.46
Mean of individual children				3.9%	Mean of individual children			47.8%

4.2.4 Overregularisations vs irregularisations

A clear dissociation is observed between overregularisation and irregularisation in existing and novel-rhyming verbs. These two patterns are more relevant to the suffixation of the verb-forms. However, in the latter, this pattern is more obvious in the children of the second group, with the children at the edges converging.

Figure 11. Novel rhyming verbs: Overregularisations vs irregularisations

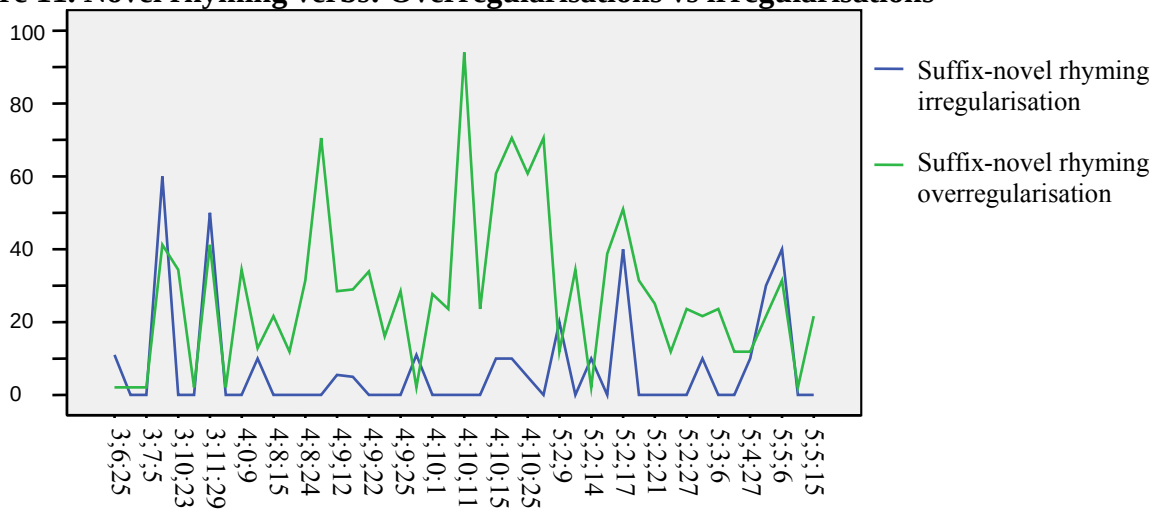
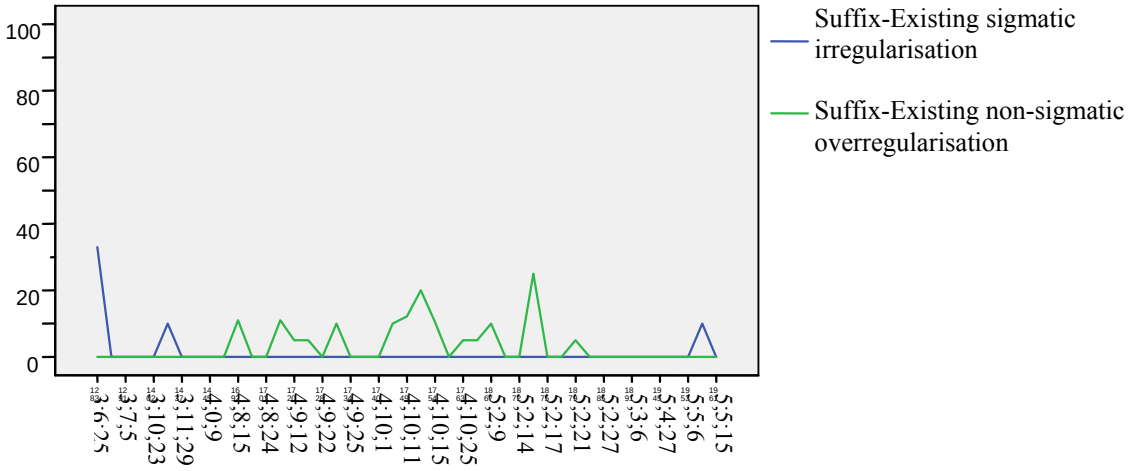
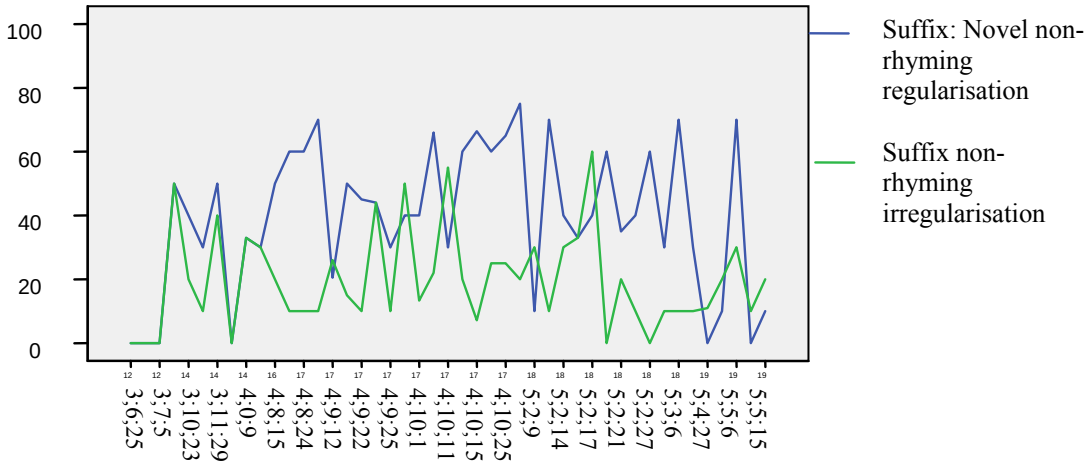


Figure 12. Existing verbs: overregularisations and irregularisations



The same pattern is also observed in the class of nonce-verbs (no analogy involved).

Figure 13. Novel non-rhyming verbs : regularisations vs irregularisations



verbs exhibited a stronger preference for regular than irregular stem-formation and suffixation. Regarding overregularisations and irregularisations, in both existing and

novel-rhyming verbs, the former outnumbered the latter. Regarding novel non-rhyming verbs, a preference for sigmatic past-tense formation as opposed to non-sigmatic is observed. The regularisation of non-rhyming verbs (which involves a rule) outperformed significantly the irregularisation of novel-rhyming verbs similar to non-sigmatic existing ones (involving analogy effects).

5. Developmental patterns

The developmental patterns of existing regular and irregular verbs are dissociated. Regarding the developmental patterns of overregularisations and irregularisations, they are distinct in all verb-classes. The adult-frequency of an irregular verb in its past-tense form appeared to be negatively correlated with its overregularisation rate for children. Frequency has been found to have an effect on overregularisation errors, but it seems to play no role in the correctness scores of regular forms. Moreover, the high overregularisation rate in the case of novel-rhyming verbs (47.8%) indicates a dissociation between regular and irregular forms, in that the absence of a form in the child's mental-lexicon or when memory traces are not strong enough and retrieval fails, the overapplication of the morphological-rule is triggered.

If we now test the *predictions* of the three models of morphological processing we arrive to the following conclusions: Regular patterns freely generalise to new forms, regardless of similarity and frequency, suggesting that they are rule-based. The generalisation of irregular patterns, in the contrary, is subject to analogy, which is a property of associative-memory and they are highly sensitive to both word frequency and similarity. Additionally, forms from the regular paradigms overapply to verbs that require irregular forms, while irregular forms overapply much less to verbs that require a regular form. Regular patterns generalise to novel forms more widely than irregular patterns, which generalise only as a function of similarity. This indicates that the scope of rules, only restricted by general principles, is wider than analogy which is similarity-based. Thus, regular generalisations have a higher productivity value because they lack such restrictions. Overall, these results showed that regular and irregular morphological patterns have different generalisation properties and developmental patterns, which supports the regular-irregular dissociation predicted by the Dual-Mechanism models of acquisition of inflection.

The present findings do not support the predictions of the Rule-based single-mechanism models, which predicted no dissociation between regular and irregular inflection. Memorisation, frequency and similarity are not in accordance with this model. Children may also overapply an irregular morphological pattern to other existing-forms or to novel-forms when there is some phonological similarity. This process is analogy-based, since overgeneralisations are carried across from existing stored forms, and are not always the result of a morpho-phonological rule.

Our findings support Rumelhart-McClelland single-mechanism model's prediction that irregular forms are stored in a memory-system, but they failed to support the model's claim that regular forms are also stored and generalised in the same way. Their prediction that no dissociation exists between regular and irregular forms is not satisfied. Being sensitive to frequency and similarity, the model fails to regularise very low-frequency regulars. The dissociation between overregularisations and irregularisations does not confront with this account since there is no significant difference in the frequency of the verbs. Moreover, the *pattern-associator* does not reliably apply regular inflection to novel-forms and it is incapable of regularizing words whose phonological representations are the same as those of familiar irregular words, claiming that both regular and irregular patterns are influenced by frequency and similarity.

6. Conclusion

In this study, the investigation of the architecture of the child's faculty extends to a morphologically richer language and the findings seem promising for the resolution of the productive/associative debate. The dual-architecture of the language-faculty predicted for adults applies also to the child's faculty. They differ, however, only quantitatively, providing that Greek-speaking children below five have not yet fully mapped the tense-concepts to the correct tense-morphology.

In order to illuminate the representation of morphologically complex words in the mental lexicon and shed light to the debate, further research on children's grammatical and lexical-semantic abilities and their relation should be conducted. The focus should go beyond morphology to production of vocabulary, metalinguistic concepts (comprehension), repetition. Moreover, a better understanding of the mechanisms involved in the acquisition of Greek morphology should derive from a multidisciplinary approach, involving the linguistic structure and the historical development of inflection, its production and comprehension in real time, how it is processed in the brain and how it is affected by language disorders. Finally, more inflectional phenomena should be investigated and research in a wide range of languages is needed.

References

Chomsky, N. (1965). *Aspects of the theory of syntax.* Cambridge, Mass: The MIT Press.

Chomsky, N. (1995). *The minimalist program.* Cambridge, Mass: The MIT Press.

Chomsky, N. & M. Halle (1968). *The sound pattern of English*. Cambridge, Mass: The MIT Press.

Clahsen, H. (1999). "Lexical entries and rules of language: a multidisciplinary study of German Inflection". *Behavioral and Brain Sciences* 22: 991-1060.

Clahsen, H., M. Ring & C. Temple (2004). "Lexical and morphological skills in English-speaking children with Williams Syndrome". In S. Bartke & J. Siegmüller (eds.), *Williams Syndrome across languages.* Amsterdam: Benjamins, 221-244.

Clahsen, H. & S. Stavrakaki (2004). "The Perfective Past-tense Test". University of Essex and Aristotle University of Thessaloniki.

Daugherty, K. & M. Hare (1994). "What's in a rule? Or, the past tense by any other name might be a connectionist net". In M.C. Mozer, P. Smolensky, D.S. Touretsky, J.L. Elman, and A.S. Weigend (eds.) *Proceedings of the 1993 Connectionist Models Summer School.* Hillsdale, N.J.: Erlbaum Associates.

Elman, J., E. Bates, M. Johnson, A. Karmiloff-Smith, D. Parisi & K. Plunkett (1996). *Rethinking innateness: A connectionist perspective on development.* Cambridge, Mass: The MIT Press.

Halle, M. & K. Mohanan (1985). "Segmental phonology of modern English". *Linguistic Inquiry* 16: 57–116.

Holton, D., P. Mackridge & I. Philippaki-Warburton (1997). *Greek: A comprehensive grammar of the Modern Greek Language*. London: Routledge.

Joanisse, M. & M. Seidenberg (2005). "Imaging the past: Neural activation in frontal and temporal regions during regular and irregular past-tense processing". C*ognitive, Affective, & Behavioral Neuroscience* 5 (3): 282-296.

Joseph, B. (1992). "The morphosyntax of the Modern Greek Verbal Complex as Morphology and not Syntax". *Studies in Greek Linguistics*, 33-43.

Ling C. X. & M. Marinov (1993). "Answering the connectionist challenge: a symbolic model of learning the past tenses of English verbs". *Cognition* 49(3): 235-90.

MacWhinney, B. & J. Leinbach (1991). "Implementations are not conceptualizations: Revising the verb learning model". *Cognition* 40: 121–57.

Marcus, G. F., S. Pinker, M. Ullman, M. Hollander, T. Rosen, T. & F. Xu (1992). *Overregularization in language acquisition. Monographs of the Society for Research in Child Development 57* (4, Serial No. 228).

Marshall, C. & H. van der Lely (2005). "A challenge to currect models of past-tense inflection: The impact of phonotactics". *Cognition* xx: 1-19.

Philippaki-Warburton, I. (1990). "I analysi toy rimatikou synolou sti Nea Elliniki" [The analysis of the verb group in Modern Greek]. *Studies in Greek Linguistics,* 119-138.

Pinker, S. (1991). "Rules of language". *Science*, 253, 530–535.

Pinker, S. & A. Prince (1992). "Regular and Irregular Morphology and the Psychological Status of Rules of Grammar". *Proceedings of the 17th Annual Meeting if the Berkeley Linguistic Society*, Berkeley, CA, 230-251.

Plunkett, K. & P. Juola (1999). "A connectionist model of English past-tense and plural morphology". *Cognitive Science: A Multidisciplinary Journal* 23 (4): 463-490.

Plunkett, K. & V. Marchman (1993). "From rote learning to system building: Acquiring verb morphology in children and connectionist nets". *Cognition* 38:43–102.

Rumelhart, D. & J. McClelland (1986). "On learning the past-tenses of English verbs". In J. McClelland, D. Rumelhart & the PDP Research Group (eds) *Parallel distributed processing: Explorations in the microstructure of cognition. Vol 1: Foundations*. Cambridge, Mass: The MIT Press, 216-271.

Thomas, M. S. C., J. Grant, Z. Barham, M. Gsödl, E. Laing, L. Lakusta, L. K. Tyler, S. Grice, S. Paterson, & A. Karmiloff-Smith (2001). "Past-tense formation in Williams syndrome". *Language and Cognitive Processes* 16: 143–76.

Tsapkini, K., Jarema, G. & E. Kehayia (2002a). "A morphological processing deficit in verbs but not in nouns: a case study in a highly inflected language". *Journal of Neurolinguistics* 15: 265-288.

Tsapkini, K., G. Jarema & E. Kehayia (2002b). "Regularity Revisited: Evidence from lexical access of verbs and nouns in Greek". *Brain and Language* 81, 103-119.

Yang, C. D. (2000). *Knowledge and learning in natural language*. Unpublished doctoral dissertation. MIT.